Risk Assessment for the Waste Technologies Industries (WTI) Hazardous Waste Incineration Facility (East Liverpool, Ohio) EPA-905-R97-002; May 1997

Introduction and Summary of Results

C O N T E N T S

I. INTRODUCTION AND SUMMARY OF RESULTS

A. Overview

In 1983, Waste Technologies Industries (WTI) received a permit from U.S. EPA Region 5 to construct and operate a hazardous waste incineration facility in East Liverpool, Ohio. As detailed in the permit application, the facility currently consists of a rotary kiln incinerator with air pollution control equipment; waste transfer, handling and storage areas; an on-site laboratory for waste testing; and associated administrative buildings. The facility began limited commercial operations in April 1993, after completion of an initial incinerator trial burn.

In 1992, U.S. EPA Region 5 performed a preliminary assessment of the potential human health risks posed by inhalation exposure (i.e., direct exposure) to emissions from the incinerator stack at the WTI facility (U.S. EPA 1992a). In 1993 and 1994, U.S. EPA's Office of Research and Development (ORD) performed two screening-level analyses of the potential human health risks posed by exposures to specific chemicals

(polychlorinated dioxins and furans) that may deposit from the air onto soil and vegetation, and accumulate in the food chain (i.e., indirect exposures) (U.S. EPA 1993a; U.S. EPA 1994a). The results of the risk assessments performed by Region 5 and ORD indicate that the potential risks through indirect exposures are higher than those through direct inhalation. Limited site-specific data were available in these preliminary assessments, which therefore relied on generic, non-site-specific assumptions regarding both facility emissions and the potential for human exposure.

In May 1993, U.S. EPA initiated a comprehensive site-specific risk assessment for the WTI facility. A Project Plan for the WTI Risk Assessment was developed by U.S. EPA (1993d), and then subjected to external peer review by independent experts in the fields of combustion technology, atmospheric dispersion modeling, exposure assessment, toxicology and risk assessment (U.S. EPA 1993e).

Consistent with the Project Plan and Peer Review Panel comments on that plan, there are three major components of the WTI Risk Assessment:

- Human Health Risk Assessment (HHRA), a detailed, site-specific, multipathway evaluation that expands upon the screening-level analyses previously performed for the WTI facility. The goal of the HHRA is to develop an understanding of the human health risks associated with exposures to routine emissions from the WTI facility using refined risk assessment techniques, and provide a basis for risk management decisions.

- Screening Ecological Risk Assessment (SERA), a screening-level analysis to determine the potential significance of risks to ecological receptors (e.g., plants, fish, and wildlife) from exposure to routine emissions from the WTI facility. The SERA for the WTI facility has been performed using conservative assumptions and approaches to determine if a refined analysis is warranted.

- Accident Analysis, an evaluation of the consequences and probability of several general classes of accidents that could potentially occur during operations of the WTI facility. The Accident Analysis also evaluates the reduction in off-site impacts that would be expected if mitigation measures succeed in shortening the duration of accidental release events.

To the extent possible, the WTI Risk Assessment relies on site-specific data to reflect more accurately emissions from the WTI facility, and local conditions in the vicinity of the facility. For this purpose, on-site meteorological data were collected, substantial emissions monitoring was conducted, and studies of the physical characteristics and populations in the vicinity of East Liverpool were undertaken.

An overview of the approaches and results of the HHRA, SERA and Accident Analysis is presented below. More complete descriptions are provided in subsequent

chapters of this Executive Summary.

B. Introduction and Overview of Results

1. Human Health Risk Assessment

a) Introduction

The regulatory framework for performing human health risk assessments has been established through a series of guidance documents issued by U.S. EPA and other regulatory agencies since the early 1980s. Key examples of guidance developed by regulatory agencies to define the objectives and approaches for human health risk assessment are listed below:

- National Research Council (NRC). 1983. Risk Assessment in the Federal Government: Managing the Process.
- U.S. EPA. 1986a. Guidelines for Carcinogen Risk Assessment.
- U.S. EPA. 1986b. Guidelines for the Health Risk Assessment of Chemical Mixtures.
- U.S. EPA. 1989. Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part A).
- U.S. EPA. 1994b. Estimating Exposure to Dioxin-like Compounds. (Review Draft)
- U.S. EPA. 1995a. Guidance for Risk Characterization.

Through these documents, guidelines for performing both qualitative and quantitative human health risk assessments have been defined. U.S. EPA has also released specific guidance for applying the general human health risk assessment methodologies to incineration facilities, including the following:

- U.S. EPA. 1990a. Methodology for assessing health risks associated with indirect exposure to combustor emissions, Interim Final.
- U.S. EPA. 1993b. Addendum to "Methodology for assessing health risks associated with indirect exposure to combustor emissions" (Review Draft).

- U.S. EPA. 1994c. Implementation guidance for conducting indirect exposure analysis at RCRA combustion units (Draft).

U.S. EPA (1994c) guidance for hazardous waste combustion facilities regulated under the Resource Conservation and Recovery Act (RCRA) specifies a two-step approach for assessing human health risks. The first step is a screening-level risk assessment performed to determine if a more detailed, site-specific evaluation of risk is warranted. For the WTI facility, a preliminary assessment of human health risks through inhalation exposure was performed by U.S. EPA in 1992, Preliminary Risk Assessment of Inhalation Exposures to Stack Emissions from the WTI Incinerator (U.S. EPA 1992a). This was followed by two screening-level assessments of multipathway exposures, one performed by ORD in 1993, Screening Level Analysis of Impacts from WTI Facility (U.S. EPA 1993a), and another performed by ORD in 1994, Update of WTI Screening Level Analysis (U.S. EPA 1994a). The following four scenarios were developed in the screening-level assessments: (1) a subsistence farmer; (2) a "high-end" farmer[1]; (3) a resident; and (4) a school age child who is expected to spend time playing in the yard at a local school. Pathways of exposure were beef consumption for the farmer scenarios only; vegetable ingestion for the resident and farmer scenarios; and soil ingestion, dermal contact and inhalation for all scenarios.

In response to citizen concerns, the U.S. EPA initiated a detailed, site-specific, multipathway risk assessment for the WTI facility, as soon as site-specific information became available. The primary goal of the HHRA is to estimate risks associated with typical and high-end exposure to routine atmospheric emissions from the WTI facility, including risks posed by indirect exposures associated with contaminant uptake via the food chain. Consistent with U.S. EPA guidelines on exposure assessment, estimates of "central tendency" exposures are developed to reflect exposures that may be experienced by typical members of the exposed population. In addition, individuals at the upper end of the exposure distribution are identified, and a sensitivity analysis of this "high-end" exposure group is conducted to assess the range of exposures in this group.

b) Overview of Results

The primary conclusions of the HHRA are summarized below:

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[1] The subsistence farmer is assumed to derive his entire beef diet from cattle raised in the vicinity of the WTI facility. The "high-end" farmer is assumed to derive a portion of his beef diet from other sources.

- For incinerator stack emissions, polychlorinated dioxins and furans (PCDD/PCDF) are identified as the primary constituents of concern. The consumption of meat and eggs from locally raised livestock, and the consumption of milk and dairy products from locally raised cows are identified as principal pathways of exposures to PCDD/PCDF. For these pathways, the estimated average total cancer risk is 1 in 1 million (1×10^{-6}) or less. Estimated average noncancer hazard index (HI) values are below 1.0, indicating that noncancer health effects associated with stack emissions would not be anticipated.

- For fugitive emissions, average cancer risks are estimated to be less than 2 in 1 million (2×10^{-6}) for all fugitive emission sources. The estimated noncancer HI values associated with exposure to fugitive emissions are substantially below 1.0, indicating that noncancer health effects would not be anticipated.

- Based on an evaluation of site-specific, incremental risk across the entire population in the vicinity of the WTI facility, it is not anticipated that any individual in this population would develop cancer as a result of exposure to routine WTI emissions.

- Predicted off-site air concentrations of U.S. EPA-regulated "criteria pollutants," such as sulfur dioxide, nitrogen oxides, hydrogen chloride, particulate matter, and lead are determined to be less than National Ambient Air Quality Standards.

2. Screening Ecological Risk Assessment (SERA)

a) Introduction

A SERA has been performed to assess the potential for routine emissions from the WTI facility to cause adverse effects to ecological receptors. For this purpose, the major ecological receptors in the vicinity of the WTI facility were identified, likely exposure pathways were defined for stack and fugitive emissions, exposures to selected ecological chemicals of concern (ECOCs) were estimated for representative indicator species, and toxicological benchmarks (based on ecologically relevant endpoints) were developed to evaluate the potential ecological effects of facility emissions.

In many ways, ecological risk assessment is much more complex

than human health risk assessment. This stems largely from the need to evaluate multiple species with widely differing exposures and toxicological sensitivities, and multiple effects at levels of organization beyond the individual (i.e., the population and community). Furthermore, chronic toxicological benchmarks are less well established for ecological risk assessments than for human health risk assessments. As a result, compared to human health risk assessments, ecological risk assessments (especially at the screening level) generally rely on more qualitative methodologies, with a resulting increase in uncertainty.

Regulatory guidance relating to specific methodologies for conducting ecological risk assessments is limited, compared to the guidance available for human health risk assessments. Key guidance documents used in the SERA, which define the objectives and approaches of ecological risk assessment, include the following:

- U.S. EPA. 1992d. Framework for Ecological Risk Assessment.

- U.S. EPA. 1994e. Ecological Risk Assessment Guidance for RCRA Corrective Action, Region 5. (Interim Draft)

Screening-level assessments represent the first phase in the ecological risk assessment process. The need for, and focus of, additional phases of assessment are determined by the results of the screening-level assessment. A SERA is the first phase in the process described in Region 5 guidance (U.S. EPA 1994e). According to the U.S. EPA's 1992 Framework for Ecological Risk Assessment (U.S. EPA 1992d), a screening ecological risk assessment "may be performed using readily available data and conservative assumptions; depending upon the results, more data then may be collected to support a more rigorous assessment." Because screening-level analyses are generally performed using conservative assumptions and approaches, the predicted risks are much more likely to be overestimated than underestimated.

The SERA for the WTI facility is intended to complement the detailed HHRA. Thus, consistent approaches and assumptions are used where appropriate in the SERA and HHRA. For example, the atmospheric dispersion modeling performed for the facility is common to both analyses. However, in contrast with the HHRA, which focuses on central tendency exposures, the SERA relies on conservative (high-end) estimates of emission rates and exposure parameters to produce reasonable upper-bound estimates of risk. Examples of conservative approaches used in the SERA include the following:

- To maximize hypothetical exposures, the ecological

receptors considered in the SERA are assumed to be present at the location of maximum impact of facility emissions, with lifetime home ranges confined to the maximum impact point. For example, for fugitive organic vapor emissions, exposures are estimated at locations where airborne concentrations are estimated to be the highest.

- Exposures are compared with toxicity data representing, where available, the lowest chronic no-effect level data for ecologically relevant endpoints (e.g., growth and reproduction).

- The SERA includes a "permit limit" scenario for stack emissions of metals. This upper-bound scenario is based on continuous emissions of stack metals at the maximum hourly emission limits, as defined in the facility's existing RCRA permit. A separate evaluation based on "expected" metal emission rates is also performed.

The SERA conducted as part of the WTI Risk Assessment provides an initial evaluation of potential risks to ecological receptors that may be directly exposed to, or indirectly affected by, routine stack emissions and fugitive emissions. It screens out those combinations of ECOCs, exposure pathways, and receptors where risks are negligible, and it provides a focus for any additional evaluation that may be warranted in a subsequent phase of assessment.

b) Overview of Results

The conclusions of the SERA are summarized below:

- The area surrounding the WTI facility contains a wide variety of terrestrial, wetland, and aquatic habitats and numerous plant, fish, and wildlife species.

- There are no recorded sightings of species listed as rare, threatened, or endangered by Federal and State agencies within one kilometer of the facility. The nearest known sightings of such species (two state-listed fish species) occur approximately four kilometers southwest of the facility in the Ohio River. Because of limited exposures, neither fish species (or any other listed species) is likely to be adversely impacted by routine facility emissions.

- The maximum estimated exposure points for both stack and fugitive emissions are within one kilometer of the facility.

- Under the expected emission scenario for metals from the incinerator stack, low to negligible ecological risks are indicated.

- For routine emissions of organic compounds from the incinerator stack, low to negligible ecological risks are indicated.

- For fugitive inorganic emissions from the ash handling facility, low to negligible ecological risks are indicated.

- For fugitive organic vapor emissions, low to negligible ecological risks are indicated except for formaldehyde. For formaldehyde, risks of relatively low magnitude are indicated for wildlife in a small area immediately adjacent to the tank farm, where inhalation exposures would be limited because of habitat considerations and thus significant adverse effects to wildlife populations and community structure are very unlikely.

- Under the "permit limit" scenario for metals in incinerator stack emissions, risks of relatively high magnitude are indicated for six metals. Risks are highest for thallium, selenium, barium, and nickel. However, as discussed in Volume VI, Chapter I, this scenario is not necessarily representative of the expected metal emissions (and resulting risks) from the facility stack.

Given the conservative assumptions used in the SERA, the likelihood of significant risks to ecological receptors as a result of expected levels of routine incinerator stack and fugitive emissions is predicted to be very low and further assessment does not appear warranted. The conservative assumptions used in the SERA and the uncertainty analysis provide a relatively high degree of confidence in this low prediction of risk. If the WTI facility were to operate continuously at the maximum hourly permit limits for metals, however, risks of relatively high magnitude are predicted in the SERA. Although it is theoretically and legally possible for the WTI incinerator to continuously emit metals at the permit limits, this is considered unlikely based on the results of stack testing. For example, the "expected" emission rate for thallium based on stack testing is over 10,000-fold lower than the permit limit (see Chapter

VI). Quantifying the likelihood and possible extent of potential effects under the permit limit scenario would require a more refined analysis. However, because the scenario is not considered to be realistic and does not reflect emissions expected during routine operations, it represents an absolute upper-bound condition. Therefore, if stack metal emissions do not reach the levels associated with this scenario, it is highly probable that routine operations of the WTI facility would not pose a significant risk to ecological receptors.

3. Accident Analysis

a) Introduction

An Accident Analysis has been performed to evaluate the likelihood and potential off-site consequences of accidents that may occur during operations of the WTI facility. Because it is not possible to identify and assess all accidents that could hypothetically occur at the facility, a subset of accidents reflecting a range of severity of consequence and probability of occurrence is evaluated. This subset has been selected to address outcomes (e.g., spills, fires) that could be caused by different initiating events. The results of this type of analysis typically provide information that can be used to reduce the likelihood, extent and impact of possible accidents, as suggested by the following key guidance documents:

- U.S. EPA, Federal Emergency Management Agency (FEMA), and U.S. Department of Transportation (U.S. DOT). 1987. Technical Guidance for Hazards Analysis: Emergency Planning for Extremely Hazardous Substances.

- FEMA, U.S. EPA, and U.S. DOT. 1993. Handbook of Chemical Hazard Analysis Procedures.

- U.S. EPA. 1996. Accidental Release Prevention Requirements: Risk Management Programs under Clean Air Act Section 112(r)(7); Final Rule.

These documents outline a general approach for performing accident analyses at a broad range of industrial facilities. The scope of accident analysis varies widely, however, and the application of standard accident analysis methodologies to hazardous waste treatment facilities is relatively complex due to the variable composition of the wastes handled. For example, while most industrial plants typically handle a limited number of chemical reagents and products, a hazardous waste treatment facility often receives chemical mixtures that can vary significantly from

day to day in terms of both composition and potential hazard.

In contrast with the HHRA and SERA, where measurements have been made to establish the composition and magnitude of emissions under normal facility conditions, there is insufficient operational history at WTI (or comparable facilities) to accurately predict the nature of releases which may occur as a result of specific accidents. Despite such uncertainties, the Accident Analysis provides useful information regarding the possible effect of facility accidents, should they occur.

A primary goal of the Accident Analysis is to identify accident scenarios that “have a reasonable likelihood of occurrence in the foreseeable future and/or which may have significant consequences in the absence of an organized, rapid, and effective response effort” (FEMA 1993). To accomplish this goal, key aspects of the Accident Analysis include the following:

- Three general classes of on-site accidents (spill, fire, and mixing of incompatible wastes) and two general classes of off-site accidents (spill and fire) are evaluated. For each type of accident, two release quantities ("typical" and "conservative") are evaluated.

- Two waste compositions ("typical" and "conservative") are evaluated for each accident event, to address uncertainties introduced by the variable composition of the waste received by the facility.

- Three sets of meteorological conditions ("typical," "conservative," and "calm/inversion") are evaluated for each accident scenario, to determine the effect of different conditions on predicted chemical concentrations.

- Severity of consequence is evaluated quantitatively through a comparison of predicted chemical concentrations in air with acute toxicity criteria.

- Probability of occurrence is evaluated semi-quantitatively through a consideration of the likelihood that different types of accidents (e.g., spills) will occur during facility operations.

Given the objectives of the Accident Analysis, probability of occurrence has been evaluated using the following guidelines presented by FEMA (1993):

Common	Expected to occur one or more times each year on average.

Likely Expected to occur at least once every 10 years on average.

Reasonably Likely Predicted to occur between once every 10 years and once every 100 years on average.

Unlikely Predicted to occur between once every 100 years and once every 1,000 years on average.

Very Unlikely Predicted to occur less than once in 1,000 years.

FEMA (1993) also presents a four-tier system for classifying the consequences of accident scenarios. The definitions provided by FEMA (1993) for categorizing consequences are not directly applicable to the WTI Accident Analysis. However, the general system described in FEMA (1993) serves as the basis for the following severity of consequence categories developed specifically for the WTI Accident Analysis using U.S. EPA Level of Concern (LOC) values as acute toxicity criteria:

Minor No exceedance of an LOC value in inhabited off-site areas; and negligible potential for off-site fatalities or serious injuries due to heat effects from a fire.

Moderate Exceedance of LOC values in inhabited off-site areas over distances of 200 meters or less; injuries due to heat effects limited to a distance of 200 meters into inhabited areas.

Major Exceedance of LOC values in inhabited off-site areas over distances between 200 meters and 2,000 meters; injuries due to heat effects limited to a distance of 2,000 meters into inhabited areas.

Catastrophic Exceedance of LOC values in inhabited off-site areas over distances greater than 2,000 meters; injuries due to heat effects extend to distances greater than 2,000 meters into inhabited areas.

A similar system based on NIOSH Immediately Dangerous to Life or Health (IDLH) values has also been developed:

Minor No exceedance of an Immediately IDLH value in inhabited off-site areas; and negligible potential for off-site fatalities or serious injuries due to heat effects

from a fire.

Moderate	Exceedance of IDLH values in inhabited off-site areas over distances of 100 meters or less; injuries due to heat effects limited to a distance of 100 meters into inhabited areas.
Major	Exceedance of IDLH values in inhabited off-site areas over distances between 100 meters and 1,000 meters; injuries due to heat effects limited to a distance of 1,000 meters into inhabited areas.
Catastrophic	Exceedance of IDLH values in inhabited off-site areas over distances greater than 1,000 meters; injuries due to heat effects extend to distances greater than 1,000 meters into inhabited areas.

The overall significance of potential accidents at the WTI facility is characterized by combining severity of consequence and probability of occurrence ratings.

b) Overview of Results

The results of the Accident Analysis are summarized below:

- For on-site accidents, only events with minor off-site consequences are considered likely to occur at the WTI facility, and only events with minor or potentially moderate off-site consequences are determined to be reasonably likely to occur.

- All on-site accident scenarios with potentially major off-site consequences are determined to be unlikely to occur, and all on-site accidents with potentially catastrophic off-site consequences are determined to be very unlikely to occur.

- For off-site accidents, events with minor consequences are determined to be, at most, reasonably likely to occur.

- All off-site accident scenarios with potentially moderate or major consequences are found to be unlikely or very unlikely to occur, and off-site accidents classified as having potentially catastrophic consequences are determined to be very unlikely to occur.

These results are consistent with the information presented in U.S. EPA's Report on Emergency Incidents at Hazardous Waste Incinerators and Commercial Treatment, Storage and Disposal Facilities (U.S. EPA 1995b). Using the data from U.S. EPA (1995b) and the definitions presented in FEMA (1993), events having moderate, major or catastrophic off-site consequences are classified as unlikely or very unlikely to occur over a facility lifetime. Only events having minor off-site consequences are classified as likely or reasonably likely to occur. This generally agrees with the consequence/probability rankings developed for the WTI facility in the Accident Analysis.

C. Structure of the Report

The full risk assessment document for WTI presents the approaches and results of the assessment, and consists of eight volumes. The titles and EPA Publication numbers for the volumes are the following:

- Volume I: Executive Summary; EPA-905-R97-002a
- Volume II: Introduction; EPA-905-R97-002b
- Volume III: Characterization of the Nature and Magnitude of Emissions; EPA-905-R97-002c
- Volume IV: Atmospheric Dispersion and Deposition Modeling; EPA-905-R97-002d
- Volume V: Human Health Risk Assessment: Evaluation of Potential Risks from Multipathway Exposure to Emissions; EPA-905-R97-002e
- Volume VI: Screening Ecological Risk Assessment; EPA-905-R97-002f
- Volume VII: Accident Analysis: Selection and Assessment of Potential Release Scenarios; EPA-905-R97-002g
- Volume VIII: Additional Analysis in Response to Peer Review Recommendations; EPA-905-R97-002h

The Executive Summary (Volume I) presents additional details on the approaches employed and results obtained in the WTI Risk Assessment. It is organized into chapters corresponding to the individual volumes of the WTI Risk Assessment report.

D. REFERENCES

NOTE: The full reference list for the Executive Summary (Volume I) is given below:

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